Vision

What information is needed for bridge inspection?

- Bridge drawings, as-built, as-designed or survey products

- Characteristic parameters, normally documented on the Identity Card of the bridge (or 'Birth Certificate')

- Bridge geometric properties including division into elements (and sub-elements) and related quantities

- Bridge schema and segmentation of elements/areas based on their importance and /or sensitivity

Vision

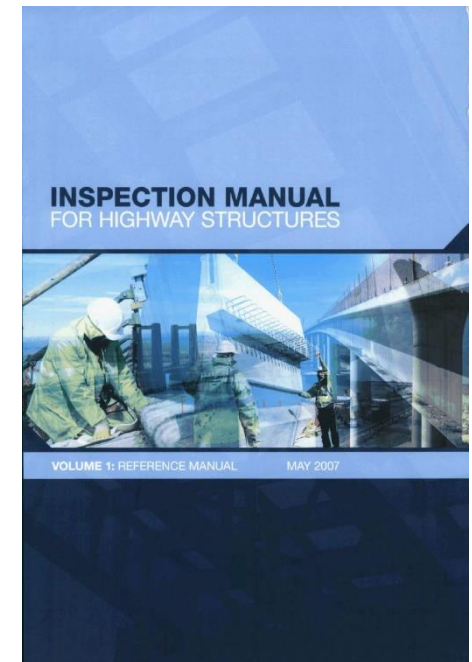## What information is needed for bridge inspection?

- Previous inspection (if conducted) findings including defects and safety issues (if any) and special issues related to the bridge

- Any treatments/ interventions/ improvements performed since the last inspection

- Environmental information and near bridge potential hazards

- Specific information regarding special equipment and temporary road safety arrangements needed for performing the inspection

Vision

What information is needed for bridge inspection?

Defects

- Inspection manuals define information requirements regarding defects

- Aimed at experienced human engineers, large margin for interpretation

- Types of defects and properties need to be extracted and transformed into an hierarchical information model

- Defects libraries/catalog should be established

INSPECTION MANUAL
FOR HIGHWAY STRUCTURES

VOLUME 1: REFERENCE MANUAL   MAY 2007

Vision

What information is needed for bridge inspection:

Defects

The most common defects are:

- Cracks

- Delamination

- Spalling

- Efflorescence

- Freeze-thaw

- Scaling

- Abrasion/wear

Vision

What information is needed for bridge inspection?

Defect information

- Type, location, extent, severity and, if possible, cause of defects

- Further structuring is required:

  - distinguish between symptom (typically the visual surface defect) and cause (based on multiple defects and requires further model knowledge)

  - Defect type dependent properties and general defect properties (e.g. orientation and location)

Vision

Why use BIM for Bridge Management Systems?

- Today's BMS do not support a transparent condition assessment

- In many cases, the sketches and notes taken by inspectors are not associated with building components

- Data on the bridge material and the used material, the pre-stress etc. is dispersed among several documents (drawings, protocols etc.)

Vision

Why use BIM for Bridge Management Systems?

- A BIM model provides

  - 3D geometry

  - component types

  - material

  - protection systems

  - any other data

- Consistent storage, transparent usage

- Localizing defects in the model
  → unambiguous interpretation

Vision
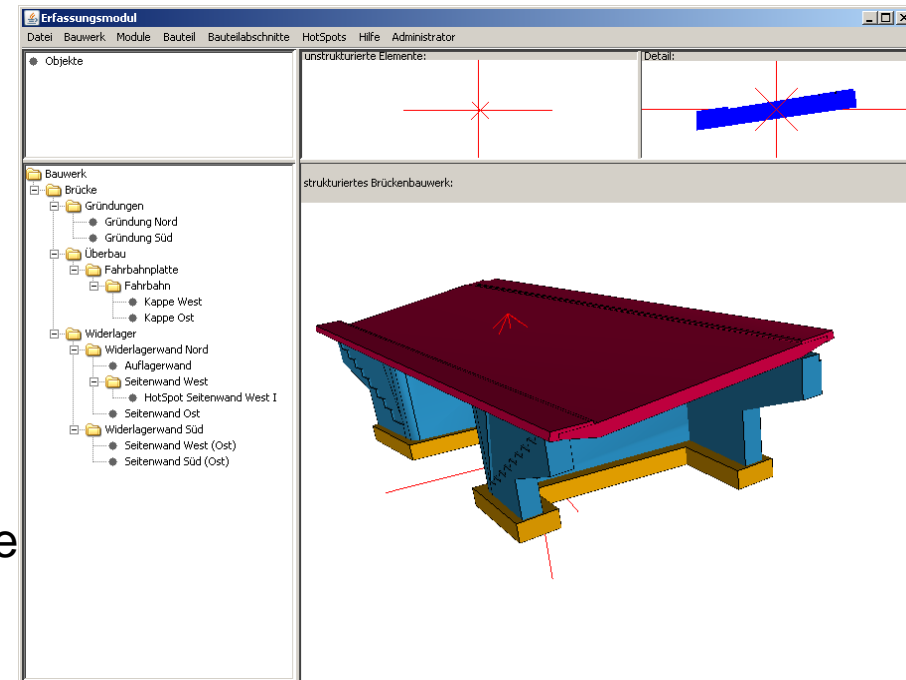
How can BIM models be acquired?

- For the large stock of existing bridges, there are no models available

- Manually reproducing the models would require too much effort

- Automation is required

  - laser-scanning

  - photogrammetry

- Challenges:

  - create real 3D geometry

  - identify semantics

Vision

SeeBRIDGE
SEMANTIC ENRICHMENT ENGINE FOR BRIDGES
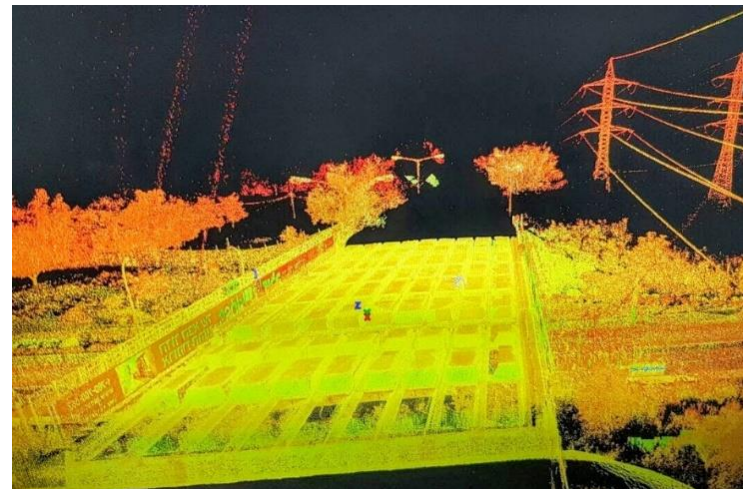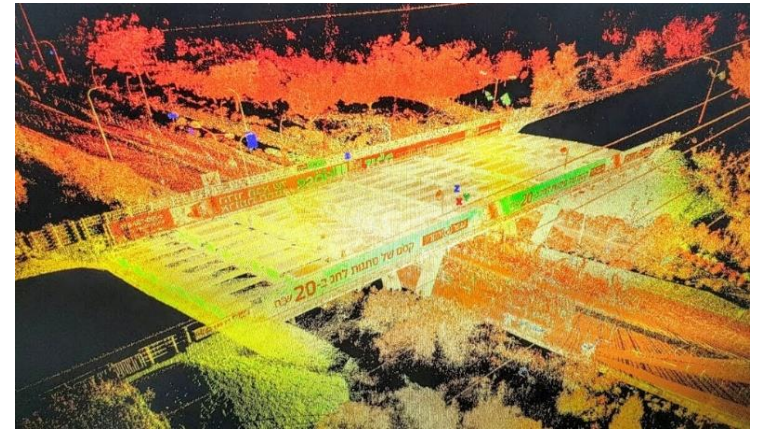
SeeBridge Process

- Comprehensive process for creating BIMs for existing bridges

- Non-contact survey

- 3D modeling

- Damage detection

- Semantic enrichment

- IFC creation
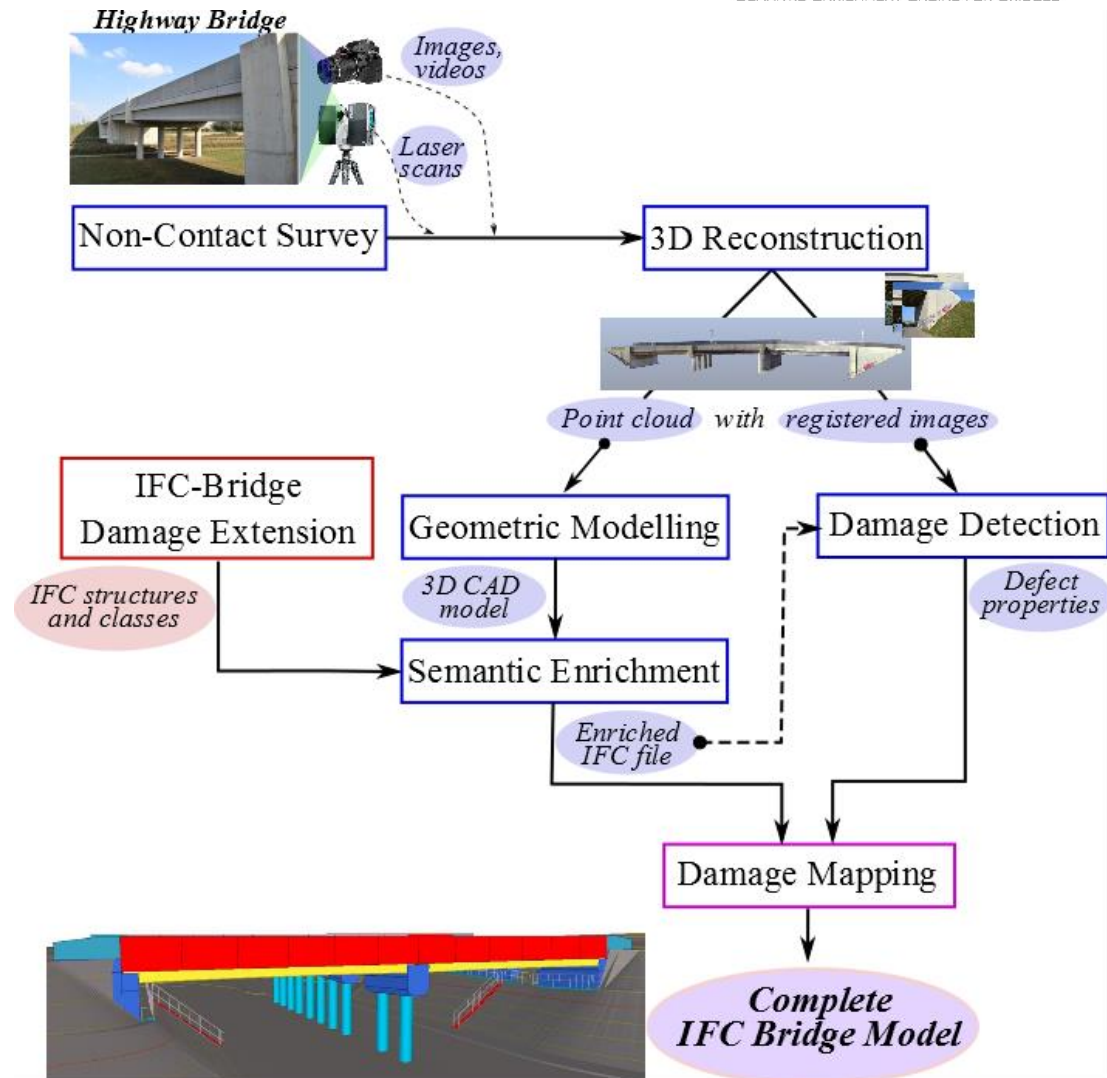
Vision

SeeBridge IDM

Information Delivery Manual describes:

- the processes,

- the data exchange scenarios

- the data requirements involved with data exchanges

- basis for
  Model View Definition (MVD)
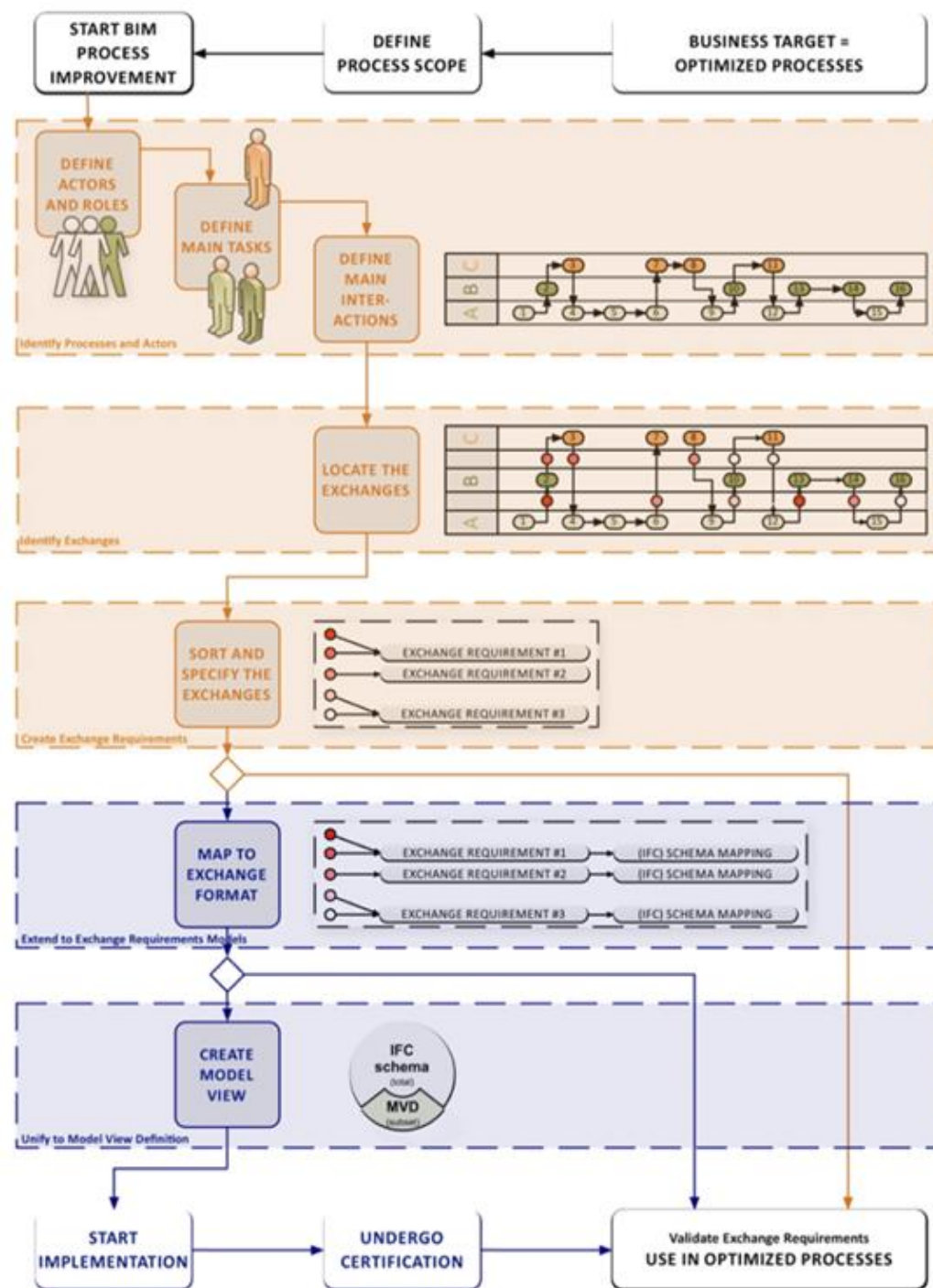
Vision

SeeBridge IDM

1. High-level process map

2. Detailed process map

Challenge:

international validity

SeeBridge Bridge Management data exchange map

SeeBridge proposed Bridge Inspection Process and data exchange map

[1] Pre-Inspection	[2] Inspection & Data collection	[3] PI Calculation	[4] QC Process	[5] Maint./rehab. Project	[6] Network Working Plan

Bridge Owner [BO]
- [1.1] Define Bridge Stock for Inspection project
- [6.2] Network Working Plan

Exchange
- NME-1
- NME-1
- NME-12

BMS [B]
- [1.2] Bridge Inspection Assignment
- [2.1.2] BIM Model Conversion and preparation
- BMS data update
- [3.1] Performance Indicators Calculation (Auto.)
- BMS data update
- [6.1] Network Analysis
- Bridge Stock finished ?

Exchange
- As Built Drawings /Survey — NME-2
- As Built Model — EM-1
- Bridge ID Data — NME-3
- Bridge Object Type Data — NME-4
- Pre-Inspection BIM Model — EM-4
- Point Cloud Data — NME-5
- Video Data — NME-6
- NME-7
- Final Inspection Model — EM-4

Bridge Inspector [I]
- Bridge BIM Model ? (yes/no)
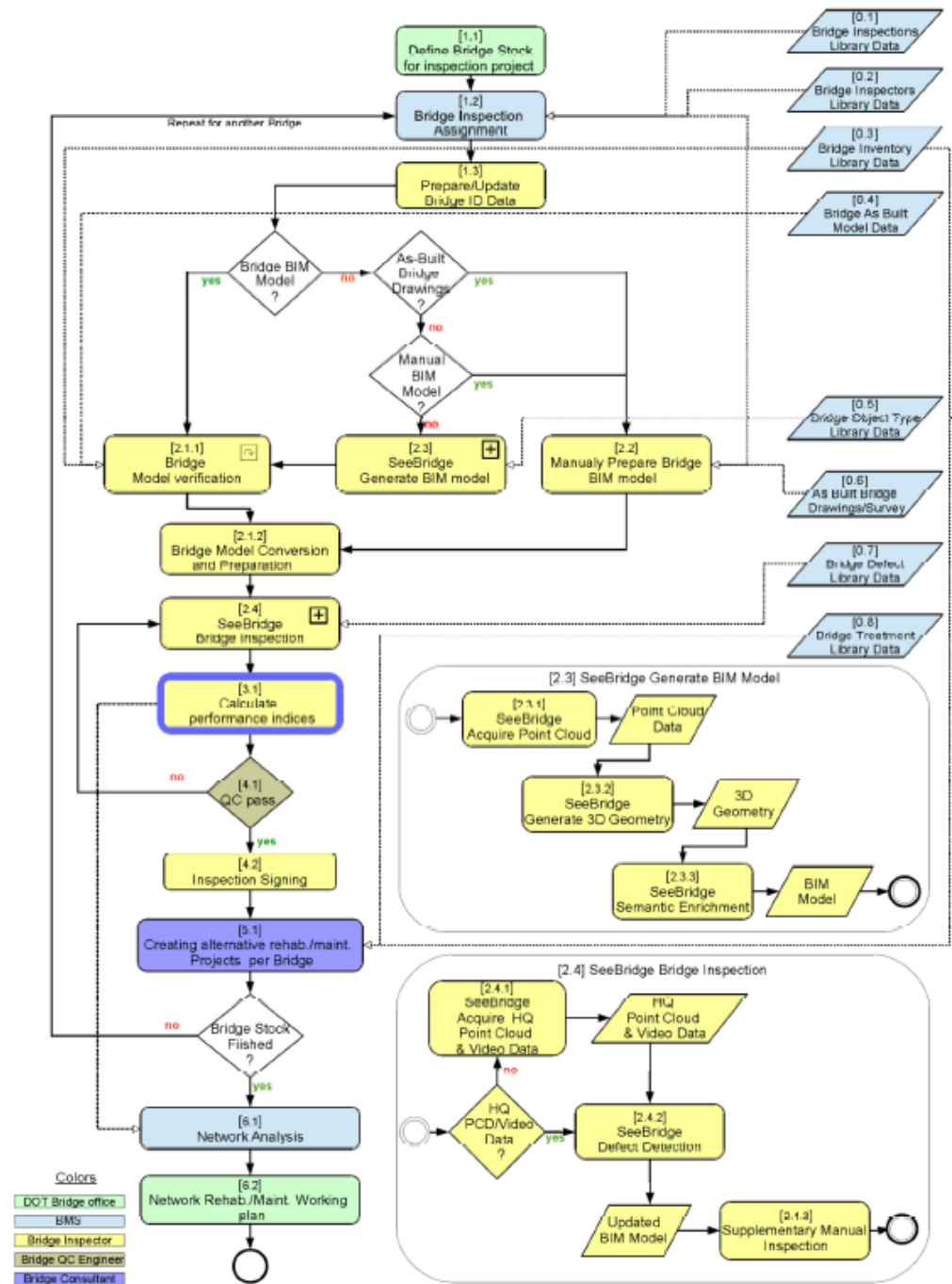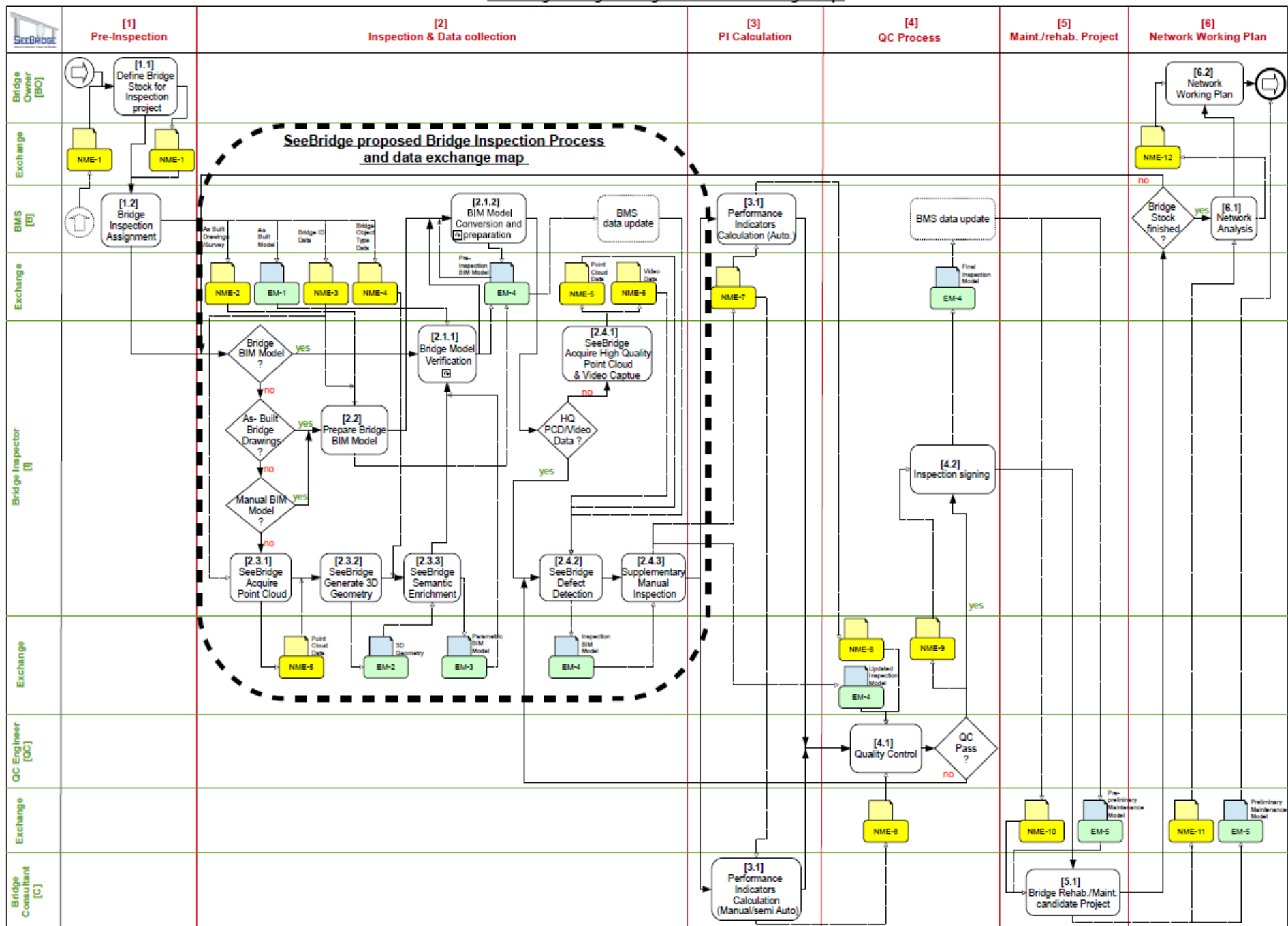- As- Built Bridge Drawings ? (yes/no)
- Manual BIM Model ? (yes/no)
- [2.1.1] Bridge Model Verification
- [2.2] Prepare Bridge BIM Model
- [2.4.1] SeeBridge Acquire High Quality Point Cloud & Video Captue
- HQ PCD/Video Data ? (yes/no)
- [4.2] Inspection signing
- [2.3.1] SeeBridge Acquire Point Cloud
- [2.3.2] SeeBridge Generate 3D Geometry
- [2.3.3] SeeBridge Semantic Enrichment
- [2.4.2] SeeBridge Defect Detection
- [2.4.3] Supplementary Manual Inspection

Exchange
- Point Cloud Data — NME-5
- 3D Geometry — EM-2
- Parametric BIM Model — EM-3
- Inspection BIM Model — EM-4
- NME-8
- NME-9
- Updated Inspection Model — EM-4

QC Engineer [QC]
- [4.1] Quality Control
- QC Pass ? (no)

Exchange
- NME-8
- NME-10
- Pre-preliminary Maintenance Model — EM-5
- NME-11
- Preliminary Maintenance Model — EM-5

Bridge Consultant [C]
- [3.1] Performance Indicators Calculation (Manual/semi Auto)
- [5.1] Bridge Rehab./Maint. candidate Project

Vision

SeeBridge proposed Bridge Inspection Process and data exchange map
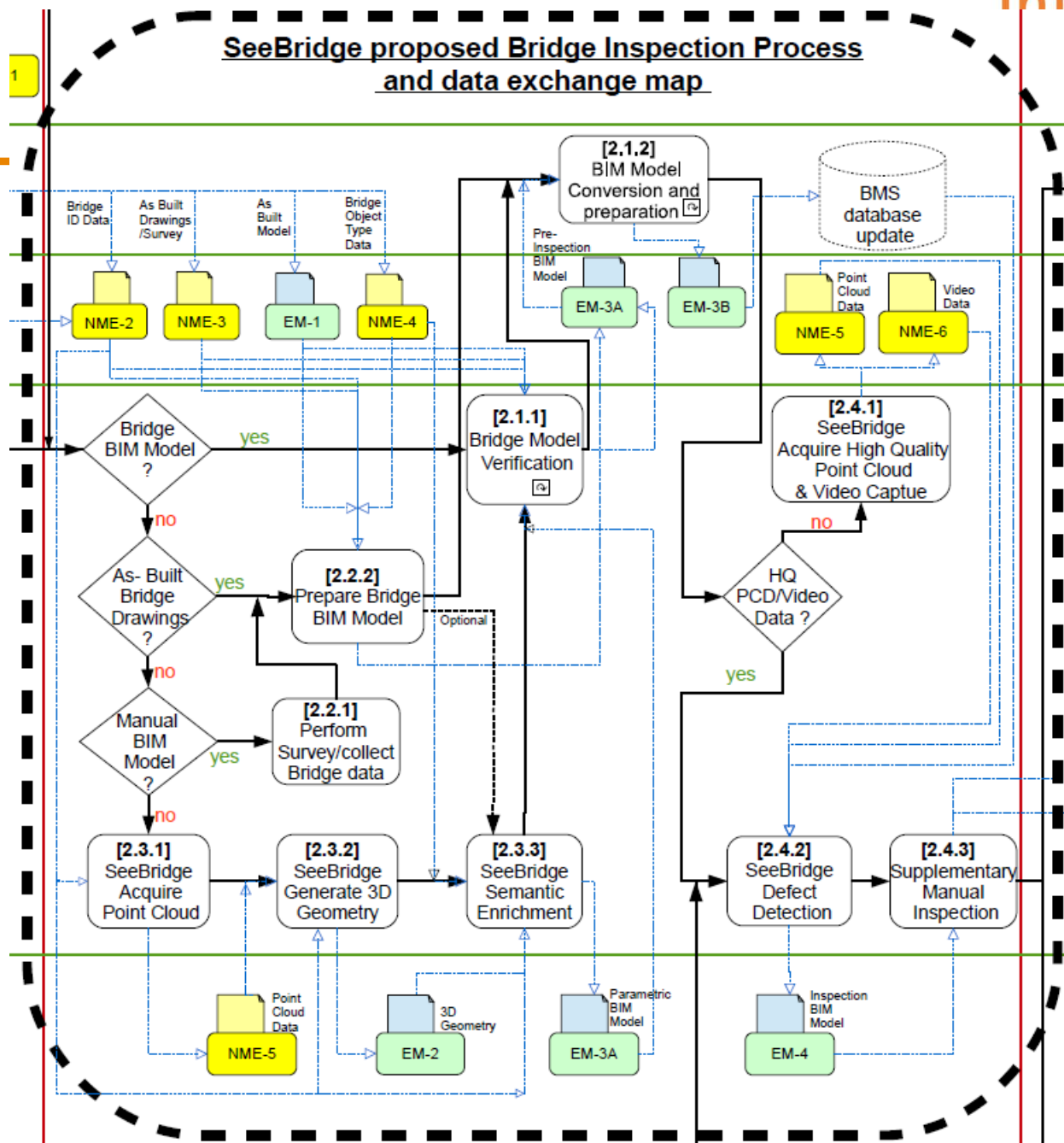
Vision

Exchange Requirements

Information Group	Information Item	Attribute Set	Attributes	Notes	Model exchange (R/O/N)				
					EM-1	EM-2	EM-3A	EM-3B	EM-4
			Owner name		R	N	R	R	R
			Owner description		O	N	O	O	R
			Owner's agent name		O	N	O	O	O
		Bridge Type	Bridge primary type	Enumerated set	O	O	R	R	R
			Bridge secondary type	Enumerated set (only for bridges where type is changed between spans)	O	O	R	R	R
Bridge Section	Span	Identification	Span ID		R	R	R	R	R
		Aggregated geometric properties	Deck area		O	O	O	O	R
			Nominal span length		R	R	R	R	R
		Span type	Span technology	Enumerated set	O	O	O	O	R
Bridge Systems	Span	Identification	Bridge System ID		O	N	R	R	R
	Superstructure		Name		O	N	R	R	R
	Substructure		Type		O	N	R	R	R
	Safety		Description		O	N	R	R	O
	Drainage	Performance Indices	Condition Index		N	N	N	N	R
	Utilities (water, electrical, communications)		Availability index		N	N	N	N	O
			Reliability Index		N	N	N	N	O
	Signs		Load rating Index		N	N	N	N	O
	Traffic		Seismic Vulnerability Index		N	N	N	N	O
	Lighting		other Index		N	N	N	N	O

Vision

SeeBridge MVD

- Subset of the IFC4 Schema
- Rules for structures, attributes and geometry
- SeeBridge items mapped to IFC entities
- SeeBridge Exchange Models mapped to IFC Model View Exchange Requirements

On the basis of the IDM an *mvdxml* template was generated featuring relevant Concept Templates.

Vision

SeeBridge MVD

- Online database BIM*Q from AEC3 for mapping of the IDM onto IFC4

- No extension of the IFC schema necessary

- Usage of predefined types and PropertySets

- The *mvdxml* is exported from BIM*Q
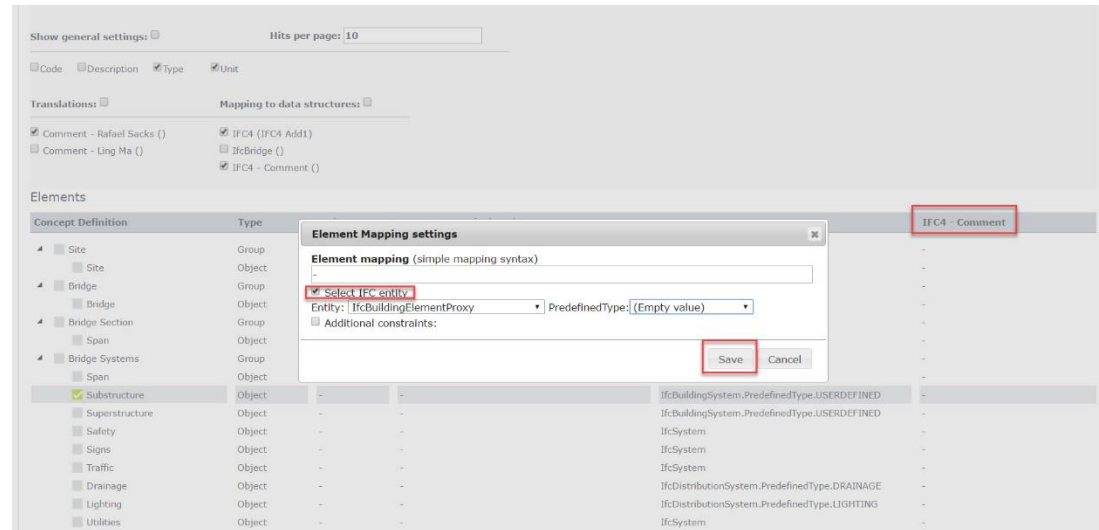
Vision

SeeBridge MVD

- IFC models must be generated according to the MVD

- The MVD is used to check IFC models for compliance

- Tool: XBIM Explorer

- Helps to ensure quality of delivered IFC files

Vision

SeeBridge MVD

- Modeling of defects as surface features (IfcSurfaceFeature)

- A defect can span several elements and is comprised of element defects

→ Current IFC tools can correctly visualize modeled defects